

## Do migrating White-crested Elaenia, *Elaenia albiceps chilensis*, use stop-over sites *en route* to their breeding areas? Evidence from the central Monte desert, Argentina

Víctor R. Cueto<sup>A,B,C</sup>, M. Cecilia Sagario<sup>A</sup> and Javier Lopez de Casenave<sup>A</sup>

<sup>A</sup>Desert Community Ecology Research Team (ECODES), Departamento de Ecología, Genética y Evolución, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires and IEGEBA (UBA-CONICET). Piso 4, Pabellón 2, Ciudad Universitaria, C1428EHA, Buenos Aires, Argentina.

<sup>B</sup>Centro de Investigación Esquel de Montaña y Estepa Patagónica (CIEMEP), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) and Facultad de Ciencias Naturales, Universidad Nacional de la Patagonia SJB, Sarmiento 849, U9200 Esquel, Chubut, Argentina.

<sup>C</sup>Corresponding author. Email: [vcueto@conicet.gov.ar](mailto:vcueto@conicet.gov.ar)

**Abstract.** Very few bird species are able to complete a single long migratory flight. Instead, a far more common strategy is that birds rest and feed almost every day, accomplishing their journeys in a series of short flights. We evaluated if White-crested Elaenia (*Elaenia albiceps chilensis*) displays evidence of *en route* migratory disposition in the central Monte desert, Argentina. Recaptures and resights were lower for White-crested Elaenias than for Greater Wagtail-tyrants (*Stigmatura budytoides*; resident) and Southern Scrub-flycatchers (*Sublegatus modestus*; spring-summer visitor). The latter species showed site fidelity between years, but White-crested Elaenia did not. Percentage of individuals with cloacal protuberance was similar among the species, but individuals with brood patches were recorded only in Greater Wagtail-tyrants and Southern Scrub-flycatchers. White-crested Elaenias showed low, medium and high fat stores, while the other species presented no fat or low fat stores. White-crested Elaenia had a high level of fruit consumption, while the other species consumed fruits occasionally or not at all. Our results support the hypothesis that the White-crested Elaenia uses the Monte desert as a stop-over area during its spring flight, and yield novel insights to fill a gap in our knowledge about the annual cycle of migrant birds in the Neotropics.

Received 5 August 2015, accepted 17 December 2015, published online 10 March 2016

### Introduction

The annual cycle of a migrant bird involves breeding and wintering in different areas and the journeys that interconnect them. There are very few species that are able to do these trips on a single long migratory flight. Instead, a far more common strategy is that birds rest and feed almost every day, accomplishing their journeys with a series of short flights (Newton 2008). A stop-over site is therefore any place where the birds stop for a certain amount of time (from hours to days) during migration (Newton 2008). Nearly a third or more of a migrant's annual cycle may be spent in migration (Rappole 2013), and 70% of that time is spent on stop-over (Alerstam and Lindström 1990), when energy expended is thought to be high relative to migratory flight (Wikelski *et al.* 2003), and mortality may be substantial (e.g. Sillett and Holmes 2002). Therefore, how well a migratory bird meets challenges that arise during migration, inclusive of stop-overs, will have consequences for their survival and future reproductive success (Moore *et al.* 2005).

Studies on Neotropical austral migrants (hereafter austral migrants) have recently increased, although there remain several gaps in the knowledge of their biology (Faaborg *et al.* 2010).

In particular, there are little data about their journeys between breeding and wintering areas. This is in part due to the high overlap of those areas (Stotz *et al.* 1996) and the difficulties in tracking these birds (now partly resolved by development of low-weight tracking devices such as geolocators, as exemplified by Jahn *et al.* 2013). However, some evidence indicates that austral migrants use stop-over sites in their journeys to breeding or wintering grounds. For example, in eastern Bolivia, Tropical Kingbirds (*Tyrannus melancholicus*) migrating to northern South America had higher fat accumulation than local residents (Jahn *et al.* 2010).

Through a comparative analysis, we evaluated if White-crested Elaenia (subspecies *Elaenia albiceps chilensis*) displays evidence of migratory disposition in the central Monte desert, Argentina. This species does not appear to breed there (Mezquida 2002; Blendinger 2005), and this area is located more than 500 km away from the nearest breeding areas found in Patagonian forests (Capllonch *et al.* 2011). We analysed the rate of recaptures and resights, subcutaneous fat stores, breeding conditions and the frugivore diets of three species with different residence and breeding status in the Ñacuñán

Biosphere Reserve, central Monte desert. We evaluated mist-net data of Greater Wagtail-tyrants (*Stigmatura budytoides*), a resident year-round at Ñacuñán (Marone 1992), Southern Scrub-flycatchers (*Sublegatus modestus*), an austral migrant that breeds in the Monte desert (Marone 1992; Mezquida 2002), and the subspecies *chilensis* of White-crested Elaenia that commonly breeds in Patagonian forests (Capllonch *et al.* 2011). Although the journey between breeding and wintering areas is a key period in the annual cycle of migratory birds, we know almost nothing about it in austral migrants. Birds *en route* commonly show low recapture rates, high fat accumulation, no breeding condition and high fruit consumption in their stop-over sites (Newton 2008). Thus, we hypothesise that White-crested Elaenias use the central Monte desert as a stop-over site during spring migration, and we predict that it should exhibit lower rates of recapture or resight, higher fat scores, no brood patch or cloacal protuberance, and a diet richer in fruits relative to Southern Scrub-flycatchers and Greater Wagtail-tyrants.

## Methods

### Study site

We conducted the study in the open Algarrobo Dulce (*Prosopis flexuosa*) woodland located in the Biosphere Reserve of Ñacuñán, central Monte desert, Argentina (34° 03' S, 67° 54' W). This habitat has a tree stratum composed of scattered Algarrobo Dulce and Chañar (*Geoffroea decorticans*) trees within an extensive tall shrub stratum dominated by Jarilla Hembra (*Larrea divaricata*). The herbaceous stratum is dominated by perennial grasses. The climate is dry and temperate, with a mean annual precipitation of 349 mm ( $n = 31$  years, 1972–2002). More than 75% of the annual rainfall occurs in the warmer months (October–March), which coincides with the growing season. Therefore, spring and summer are warm and rainy (269 mm), whereas autumn and winter are cold and dry (80 mm), although precipitation varies widely among years.

### Bird sampling

We conducted capture and observational surveys during spring (late November and early December) from 2004–2008. We banded birds (with numbered aluminium and colour bands) that had been captured using 30 nylon mist-nets (12 m × 3 m, 38 mm mesh size) located on a permanent 10 ha plot. Nets were installed 50 m apart in three parallel lines. During each sampling period nets were opened for 4–5 h after sunrise on six consecutive days, provided that weather conditions were not adverse (i.e. not rainy, windy or extremely cold or hot). After net sampling, we conducted intensive daily searches for colour-banded birds in the permanent 10 ha study plot and 50–100 m beyond its boundaries (a minimum total search area of 18 ha). Searches were conducted during the first 4 h after sunrise and the last 2 h before sunset, for a minimum of 10 days and until we had not seen any new banded individuals after searching for 10 h.

For each captured or recaptured individual we recorded subcutaneous fat stores, size of the cloacal protuberance, and development status of the brood patch. We assigned a fat class on the basis of the following fat accumulation in the furculum and abdomen (see Ralph *et al.* 1993): no fat (0); less than 5% of

fat in furculum and no fat in the abdomen (1); a thin layer in the furculum that covers less than 33% and small traces in the abdomen (2); fat covers 50% of the furculum and does not cover all the area of the abdomen (3); fat covers 75% of the furculum, is slightly mounded, with a thin layer covering the abdomen (4); fat covers the furculum and the fat in the abdomen is mounded (5); furculum and abdomen are greatly mounded (6); and large fat pads in the furculum and abdomen meet (7). Following recommendations in Ralph *et al.* (1993) the cloacal protuberances were categorised as: none (0); small (1); medium (2); and large (3). The brood patch development was categorised as follows: no brood patch present (0); smooth skin (1); vascularised (2); and wrinkled (3).

We assessed the frugivorous fraction of the diet of birds by counting fruit seeds and remains of the pericarp of fleshy fruits in the digestive tract of mist-netted individuals. We obtained the content of the digestive tract by using the flushing method, which allows the effective collection of different food items (Rosenberg and Cooper 1990). We preserved all tract contents in alcohol, and different fruit items were taxonomically identified and sorted in the laboratory under a dissecting microscope. Since our goal was to depict the frugivorous fraction of the diet, remains of arthropods were not considered in analyses. The contribution of fruits of every plant species to the diet was expressed as the percentage of samples with fruit remains (seeds or pericarp) in relation to the total number of digestive tracts for each bird species. We counted the number of fruit seeds in each digestive tract, and averaged the values across all individuals for each bird species.

### Statistical analysis

We used Chi-square Analysis of Contingency Tables (Agresti 2002) to evaluate whether subcutaneous fat stores, size of the cloacal protuberance, and development of the brood patch were independent of bird species. The test should not be used if expected frequencies are lower than 5 (Agresti 2002); therefore, the original categories of each variable were reorganised to do the tests. Fat stores were categorised into four classes: none (0); light (1 and 2); medium (3 and 4); and heavy (5, 6 and 7). Cloacal protuberance was categorised as absent (0) or present (1, 2 and 3), and brood patch was categorised as absent (0) or present (1, 2 and 3).

## Results

We captured 96 White-crested Elaenias, 41 Southern Scrub-flycatchers and 43 Greater Wagtail-tyrants. The recapture and resight percentage within sampling periods was lower for White-crested Elaenia (2%) than for Southern Scrub-flycatcher (24%) and Greater Wagtail-tyrant (46%). We never recaptured or resighted a White-crested Elaenia after the day of its first capture, though we had recaptures during the same day. Individual B004161 was captured 1 December 2005 at 730 h and recaptured at 1130 h at 350 m from its first capture location, and individual B004505 was captured 1 December 2006 at 700 h and recaptured at 830 h at 50 m from its first capture location. Furthermore, during the 10-day period that we searched for colour-banded individuals we did not resight any White-crested Elaenia, nor did we recapture or resight any White-crested Elaenia between years.

In contrast, 21% of Southern Scrub-flycatchers and 40% of Greater Wagtail-tyrants were recaptured or resighted in different years.

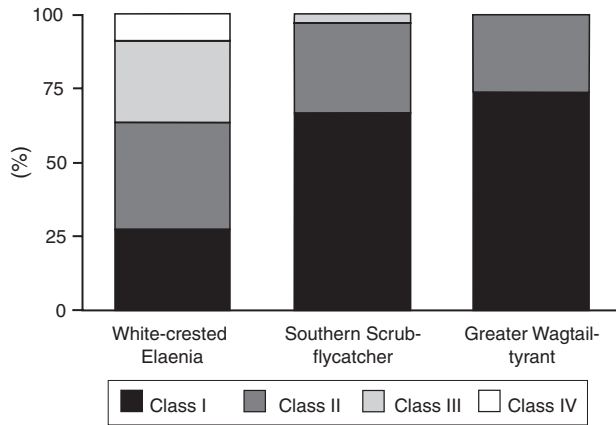
Fat store level differed among species ( $X^2_6=35.11$ ,  $P<0.0001$ ). White-crested Elaenia showed a wide range of values, including individuals with heavy fat stores as well as without fat (Fig. 1). In contrast, more than 60% of Southern Scrub-flycatcher and Greater Wagtail-Tyrant individuals had no subcutaneous fat and the rest only showed low fat store values (Fig. 1).

The presence of a developed cloacal protuberance was independent of bird species ( $X^2_2=4.37$ ,  $P=0.11$ , Fig. 2a), while the presence of a brood patch depended on the bird species ( $X^2_2=102.59$ ,  $P<0.0001$ ). More than 50% of Southern Scrub-flycatchers and 80% of Greater Wagtail-Tyrants showed developed brood patches, no White-crested Elaenias were captured in that condition during our study (Fig. 2b).

We evaluated the frugivore diet of 55 White-crested Elaenias, 20 Southern Scrub-flycatchers, and 9 Greater Wagtail-tyrants. White-crested Elaenias and Greater Wagtail-tyrants consumed fruits, and in all cases we only found seeds and pericarp remains of *Lycium* spp. In digestive tracts of Southern Scrub-flycatchers we did not find remains of fleshy fruits. We found fruit remains in 56% of the digestive tracts of White-crested Elaenias and in 33% of Greater Wagtail-tyrants. The average number of *Lycium* spp. seeds in digestive tracts of White-crested Elaenias was 21.5 seeds (range 1–122) while for Greater Wagtail-tyrants it was 5.0 seeds (range 3–6). Considering that an average *Lycium* spp. fruit has 18.5 seeds (range 4–41, J. Lopez de Casenave, unpubl. data), the maximum number of seeds found in digestive tracts suggests that White-crested Elaenia actively consumed fruits, whereas Greater Wagtail-tyrant consumed them occasionally.

**Discussion**

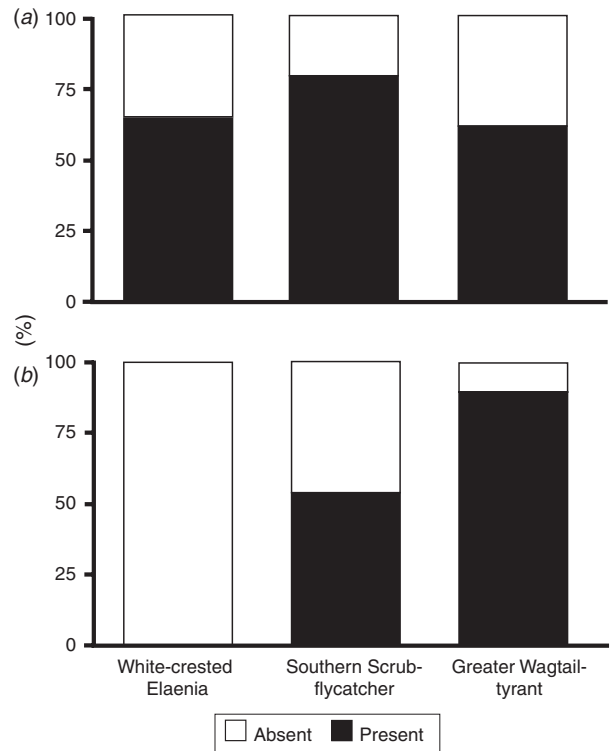
White-crested Elaenias in the central Monte desert exhibited features commonly associated with spring passage migrants that



**Fig. 1.** Percentage of individuals of White-crested Elaenia (*Elaenia albiceps chilensis*), Southern Scrub-flycatcher (*Sublegatus modestus*), and Greater Wagtail-tyrant (*Stigmatura budyoides*) with each fat store class in spring at Ñacuñán Biosphere Reserve, central Monte desert, Argentina. Class I: no fat stores; Class II: light fat stores; Class III: medium fat stores; and Class IV: heavy fat stores. For more details see Methods.

are using stop-over sites to rest and feed (Newton 2008; Rappole 2013). In contrast to migratory Southern Scrub-flycatchers and resident Greater Wagtail-tyrants, White-crested Elaenias did not show site fidelity between years and appeared to remain at the site only briefly. Our results on fat stores also support the hypothesis that White-crested Elaenias pass through the central Monte desert, and use this zone for stop-over during spring migration. Almost all breeding residents and migrants that breed at the study site lack fat accumulation; in contrast, White-crested Elaenia exhibited high heterogeneity in fat stores. Capllonch *et al.* (2011) also reported White-crested Elaenias with high fat accumulation during spring in several Monte desert localities, and the same pattern was observed in Fray Jorge National Park, Chile (Pyle *et al.* 2015). These results suggest that White-crested Elaenias on spring migration through the Monte desert and central Chile are ‘refueling’ during their journey to the main breeding grounds in Patagonia.

Many songbirds switch from feeding on insects to fruits during their migration (Parrish 1997). As has been suggested, high consumption of fruits by birds *en route* plays an important role in determining the energetic performance during migratory flight (McWilliams *et al.* 2004). Our results indicate the importance of *Lycium* spp. fruits in the diet of White-crested Elaenias, and consumption of these fruits may help accumulate fat to fuel their migration. Williamson (1975) also reported high consumption levels of fruits in spring migrating White-crested Elaenias



**Fig. 2.** Percentage of individuals of White-crested Elaenia (*Elaenia albiceps chilensis*), Southern Scrub-flycatcher (*Sublegatus modestus*), and Greater Wagtail-tyrant (*Stigmatura budyoides*) with cloacal protuberance (a) and brood patch (b) in spring at Ñacuñán Biosphere Reserve, central Monte desert, Argentina.

in La Pampa Province, Argentina. However, White-crested Elaenia also has high consumption of fruits at its breeding sites (Amico and Aizen 2005; Bravo *et al.* 2015). Therefore, fruits appear to be a general part of its diet, and in contrast to other migrant songbirds, frugivory would not be a special condition during migration.

During the study we did not capture any White-crested Elaenia with a brood patch. This is clear evidence that the species does not breed in the Monte desert, as was indicated by Mezquida (2002) and Blendinger (2005), and supports our hypothesis that White-crested Elaenias use this zone for stop-over during spring migration. In contrast, captures of White-crested Elaenias with a cloacal protuberance in a similar percentage to that of residents and migrants that breed at the study site did not support our expectations. This could be associated with a male strategy of being prepared for reproduction when arriving on the breeding grounds, as has been observed in several migrant species (Quay 1985). Cloacal protuberance development may therefore not be a key factor to indicate whether a bird is using a site to breed or is *en route* to the breeding area.

In summary, our results support the hypothesis that White-crested Elaenia uses the central Monte desert as a stop-over area during spring migration to its main breeding grounds in the Patagonian forests. Notwithstanding, there is a need for more studies on this species in the Monte desert. In particular, we need to know the length of the stop-over, whether birds gain weight and fat during stop-over, and whether they use the same strategy on fall migration.

## Acknowledgements

We thank Alex Jahn for providing comments that greatly improved this paper. Special thanks to Shazeeda Ameerally and Alex Jahn for the English language editing of the manuscript. Research was financed by CONICET, FONCYT-ANPCyT, and Universidad de Buenos Aires, all from Argentina. This is contribution number 96 of the Desert Community Ecology Research Team (Ecodes), Argentine Institute for Arid Zones Research (IADIZA-CONICET) and Facultad de Ciencias Exactas y Naturales (Universidad de Buenos Aires).

## References

- Agresti, A. (2002). 'Categorical Data Analysis.' (John Wiley & Sons: Hoboken, NJ.)
- Alerstam, T., and Lindström, A. (1990). Optimal bird migration: the relative importance of time, energy, and safety. In 'Bird Migration: Physiology and Ecophysiology' (Ed. E. Gwinner) pp. 331–335. (Springer: Berlin, Germany.)
- Amico, G. C., and Aizen, M. A. (2005). Dispersión de semillas por aves en un bosque templado de Sudamérica austral: ¿quién dispersa a quién? *Ecología Austral* **15**, 89–100.
- Blendinger, P. G. (2005). Abundance and diversity of small-bird assemblages in the Monte desert, Argentina. *Journal of Arid Environments* **61**, 567–587. doi:10.1016/j.jaridenv.2004.09.017
- Bravo, S. P., Cueto, V. R., and Amico, G. C. (2015). Do animal-plant interactions influence the spatial distribution of *Aristotelia chilensis* shrubs in temperate forests of southern South America? *Plant Ecology* **216**, 383–394. doi:10.1007/s11258-014-0443-7
- Capllonch, P., Álvarez, M. E., and Blendinger, P. G. (2011). Sobre la migración de *Elaenia albiceps chilensis* (Aves: Tyrannidae) en Argentina. *Acta Zoológica Lilloana* **55**, 229–246.
- Faaborg, J., Holmes, R. T., Anders, A. D., Bildstein, K. L., Dugger, K. M., Gauthreaux, S. A. Jr, Heglund, P., Hobson, K. A., Jahn, A. E., Johnson, D. H., Latta, S. C., Levey, D. J., Marra, P. P., Merkord, C. L., Nol, E., Rothstein, S. I., Sherry, T. W., Sillett, T. S., Thompson, F. R., and Warnock, N. (2010). Recent advances in understanding migration systems of New World landbirds. *Ecological Monographs* **80**, 3–48. doi:10.1890/09-0395.1
- Jahn, A. E., Levey, D. J., Farias, I. P., Mamani, A. M., Vidoz, J. Q., and Freeman, B. (2010). Morphological and genetic variation between migratory and non-migratory Tropical Kingbirds during spring migration in central South America. *The Wilson Journal of Ornithology* **122**, 236–243. doi:10.1676/09-086.1
- Jahn, A. E., Levey, D. J., Cueto, V. R., Pinto Ledezma, J., Tuero, D., Fox, J. W., and Masson, D. (2013). Long-distance bird migration within South America revealed by light-level geolocators. *The Auk* **130**, 223–229. doi:10.1525/auk.2013.12077
- Marone, L. (1992). Estatus de residencia y categorización trófica de las especies de aves en la Reserva de la Biosfera de Ñacuñán, Mendoza. *Hornero* **13**, 207–210.
- McWilliams, S. R., Guglielmo, C., Pierce, B., and Klaassen, M. (2004). Flying, fasting, and feeding in birds during migration: a nutritional and physiological ecology perspective. *Journal of Avian Biology* **35**, 377–393. doi:10.1111/j.0908-8857.2004.03378.x
- Mezquida, E. T. (2002). Nidificación de ocho especies de Tyrannidae en la Reserva de Ñacuñán, Mendoza, Argentina. *Hornero* **17**, 31–40.
- Moore, F. R., Smith, R. J., and Sandberg, R. (2005). Stopover ecology of intercontinental migrants: *en route* problems and consequences for reproductive performance. In 'Birds of Two Worlds: The Ecology and Evolution of Migration.' (Eds R. Greenberg and P. P. Marra) pp. 251–261. (John Hopkins Press, Baltimore, MD.)
- Newton, I. (2008). 'The Migration Ecology of Birds.' (Academic Press: London, United Kingdom.)
- Parrish, J. D. (1997). Patterns of frugivory and energetic condition in Nearctic landbirds during autumn migration. *The Condor* **99**, 681–697. doi:10.2307/1370480
- Pyle, P., Engilis, A., Jr, and Kelt, D. A. (2015). 'Manual for ageing and sexing landbirds of Bosque Fray Jorge National Park and North-central Chile, with notes on occurrence and breeding seasonality.' (Special Publication of the Occasional Papers of the Museum of Natural Science: Baton Rouge, LA.)
- Quay, W. B. (1985). Cloacal sperm in spring migrants: occurrence and interpretation. *The Condor* **87**, 273–280. doi:10.2307/1366894
- Ralph, C. J., Geupel, G. R., Pyle, P., Martin, T. E., and Desante, D. F. (1993). Handbook of field methods for monitoring landbirds. USDA Forest Service General Technical Report PSW-GTR-144, Pacific Southwest Research Station, Albany, CA.
- Rappole, J. H. (2013). The Avian Migrant: the Biology of Bird Migration. (Columbia University Press, New York, NY.)
- Rosenberg, K. V., and Cooper, R. J. (1990). Approaches to avian diet analysis. *Studies in Avian Biology* **13**, 80–90.
- Sillett, T. S., and Holmes, R. T. (2002). Variation in survivorship of a migratory songbird throughout its annual cycle. *Journal of Animal Ecology* **71**, 296–308. doi:10.1046/j.1365-2656.2002.00599.x
- Stotz, D. F., Fitzpatrick, J. W., Parker, T. A., and Moskovits, D. K. (1996). 'Neotropical Birds: Ecology and Conservation.' (University of Chicago Press: Chicago, IL.)
- Wikelski, M., Tarlow, E. M., Raim, A., Diehl, R. H., Larkin, R. P., and Visser, G. H. (2003). Avian metabolism: costs of migration in free-flying songbirds. *Nature* **423**, 704. doi:10.1038/423704a
- Williamson, J. (1975). Alimentación de algunas aves de La Pampa. *Hornero* **11**, 322–324.